

Glaucoma Case Finding in Philadelphia

By EMILY K. HANKLA

AT LEAST ONE-EIGHTH of the blindness in the United States is caused by glaucoma, according to some estimates (1), and with the aging of the population it is probable that this condition will increase in importance. Although there is general agreement among ophthalmologists that the most important factor in the management of chronic simple glaucoma is its early detection, only one mass case-finding campaign has been reported in detail, that of the Philadelphia Committee for the Prevention of Blindness.

From 1944 through 1950, the period covered by this report, a total of 10,000 persons was screened, the majority during the fiscal year 1950, when the Public Health Service supported the committee's work. Earlier papers by the executive director of the committee and by ophthalmologists who took part in the case-finding procedure have described the background, methods used, and results of the Philadelphia program (2, 3). This paper presents a detailed description of the population screened, the initial tonometer readings, and the case-finding yield at various tonometer readings above the screening level.

Screening and Retesting Examinations

The screening examination, which was performed by certified ophthalmologists, included

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external examination for gross pathology, ophthalmoscopic examination of the fundus, visual acuity tests, and intraocular tension readings, using calibrated Schiøtz tonometers and a modification of the Schiøtz conversion chart (4). After these procedures ran smoothly, people were examined at the rate of 20 per hour. The screening tests were conducted in the plants where the screenees worked.

As has been found desirable in other mass case-finding programs, persons with positive screening results were retested before being referred to private physicians. Criteria for retesting were, in general, suspicious clinical findings or tonometer readings of 25 mm. Hg or more. The glaucoma screenee who returned for recheck might be classified as negative after a second or third tonometer reading; or before the examining physician decided upon a negative diagnosis or referral to a private physician, the screenee might have his fields of vision charted or a water provocative test or gonioscopic examination performed.

The retest clinic provided an additional service. Persons with borderline symptoms—persistent or intermittent tonometer readings of 28 to 30 mm. Hg and/or a rise of 6 to 8 mm. Hg on the Marx water-drinking test—were followed until a diagnosis of glaucoma could be established or ruled out. There were 71 such cases when they were classified in 1951 (3). In addition, there were 100 "observation" cases, persons with no indication of glaucoma except slightly to moderately elevated intraocular tension, a difference of 4 mm. or more in tension readings between eyes, or a family

Table 1. Number and percentage of employed persons screened for glaucoma, by sex and age groups, in relation to the total population of Philadelphia¹

Age group	Total population		Number of persons employed		Persons screened ²			
					Number		Percent of employed	
	Male	Female	Male	Female	Male	Female	Male	Female
All ages, 35 years and over	463, 300	516, 200	358, 900	153, 000	6, 496	3, 457	1. 81	2. 26
35-44 years	145, 900	173, 700	127, 400	64, 500	1, 830	1, 176	1. 44	1. 82
45-64 years	239, 900	248, 000	198, 200	80, 300	4, 399	2, 173	2. 22	2. 71
65 years and over	77, 500	94, 500	33, 300	8, 200	267	108	. 80	1. 32

¹ Bureau of the Census: 1950 Census of Population Preliminary Reports, Series PC-5, No. 36, Aug. 29, 1951.

² 47 screenees under age 35 omitted from this table.

history of glaucoma. These were kept under observation until they had remained symptom-free for several years or had developed additional symptoms.

Some persons with very high tonometric readings and suspicious clinical findings were referred immediately to private ophthalmologists or to clinics. Diagnoses were obtained for these patients. Very few who were advised to have a tonometric recheck or further examination refused. Only 19 persons were lost from the study.

Persons Screened

The group screened, although numbering fully 10,000 persons, is admittedly not a representative sample of the population of Philadelphia. For example, those not employed on account of age, sex, poor vision, or other reasons were not represented since the program covered only employees of firms who cooperated in the study. Included among the 10,000 were 215 department-store shoppers who were screened as a demonstration. The other 9,785 persons were known to be working in factories, stores, or Government installations when they were first tested (table 1).

The screenees were predominantly white (90 percent), as is the population of Philadelphia (87 percent white). Fifty-seven and one-half percent were white males and 32.3 percent were white females. There were about three times as many nonwhite males as nonwhite females.

On the other hand, comparison of the number of screenees with the number of Philadelphia residents of each sex employed in April 1950 indicates that a slightly higher percentage of female (2.3) than of male (1.8) employees were included among those screened for glaucoma. The relatively greater coverage of female workers was true of each of the broad age categories and was pronounced among employees 65 years of age or older.

Attempting to reach the group most likely to have glaucoma, the committee concentrated on people over 35 and discouraged younger persons from entering the screening line. People are less likely to be employed after they reach 65 and, of the individuals within that age bracket employed in Philadelphia, relatively fewer were included among the screenees. Therefore, most of the screenees were between 35 and 65 years of age.

Intraocular Tension Readings

Tonometer readings for both eyes were reported for 9,645 persons. The distribution of initial tonometer readings in the eye with highest tension, expressed in millimeters of mercury, is illustrated in figure 1. Since no attempt was made to smooth out irregularities, a tendency for certain readings to appear more often than adjacent ones is apparent. This is a familiar phenomenon to anyone acquainted with other measurements which result from translating,

according to a calibration chart, the positions of a wavering pointer on a small scale.

To illustrate, more than one-fifth (22 percent) of the group tested had initial tensions of 22 mm. Hg, the modal, median, and mean reading for the eye with the highest tension. On both sides of this peak, there were fewer readings than would be expected in a normal distribution. For only 322 persons was the initial high tension given as 21 mm. Hg. On the right-hand side of the mode, the slope is more regular but there are only 3 millimeters between the modal value and 25 mm. Hg, which was adopted as the screening level. The wide and one-sided range at the base, from 11 to 65 mm. Hg, with a few high values representing the more abnormal or unusual occurrences, is also characteristic of measurements of blood pressure, blood sugar, or hemoglobin.

Of the 9,645 persons with tonometer readings for both eyes, 1,056 (11 percent) had intraocular tensions in one or both eyes equivalent to 25 mm. Hg or more, the screening level which had been adopted. Of these, 815 were called back for reexamination or put under medical care. Glaucoma or "borderline" intraocular tension was diagnosed in 21.2 percent of the 1,056 suspects with initial tensions of 25 mm. Hg or more, or 2.2 percent of the total number screened. Virtually none of the glaucoma patients had any previous knowledge of their disease.

In figure 2, tension readings above the screening level of 25 mm. Hg have been grouped in 3 mm. intervals. Even in the first interval, among those with initial readings of 25 through 27 who were retested, 10 percent (32 cases) were classified as having glaucoma or "borderline" tensions. With higher initial readings, the percentage of positive classifications increased. Original tonometer readings of 40 mm. Hg Schiøtz or higher were followed in all instances by diagnoses of glaucoma.

It should be noted, though, that the cases picked up at the 40 mm. Hg Schiøtz screening level numbered only 20, compared with 32 instances of glaucoma or "borderline" intraocular tension with initial readings of 25 to 27 mm. Hg and 90 at the 28 to 30 mm. Hg level. Moreover, all but one case with initial tensions of 40 mm. Hg or more were later classified as advanced

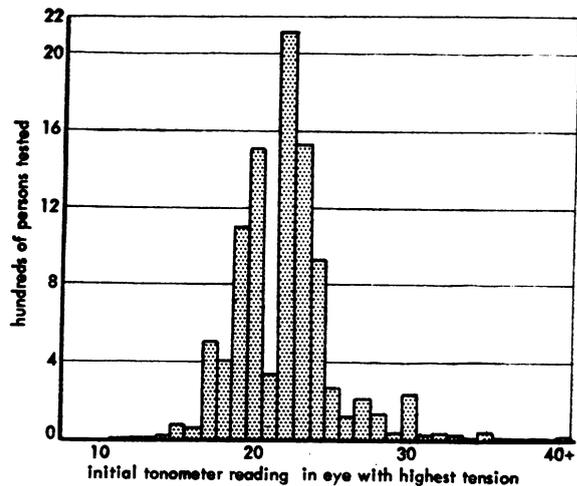


Figure 1. Number of persons tested, by initial tonometer reading (in mm. Hg Schiøtz).

glaucoma, while 95 cases (78 percent) with original tensions of 25 to 30 mm. Hg were either early glaucoma or "borderline" intraocular tension. (See figure 3.)

Age and Intraocular Tension

With age there is an increase in the percentage diagnosed as having glaucoma or "borderline" intraocular tension, as may readily be seen in table 2.

If all cases are grouped together, and distributed by their age, their ratio to the total num-

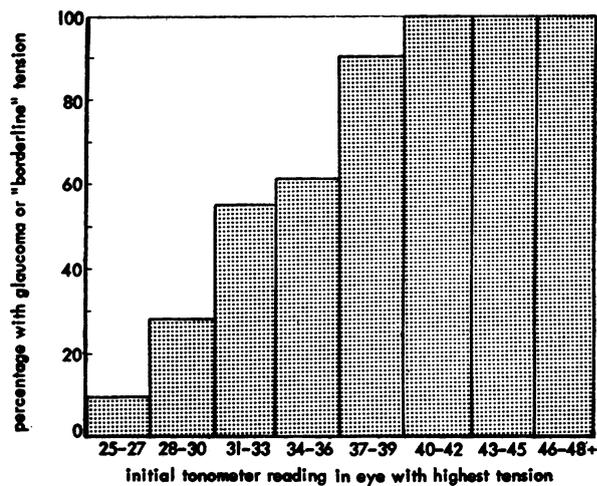


Figure 2. Percentage of persons with confirmed glaucoma or "borderline" intraocular tension who had initial tonometer readings (in mm. Hg (Schiøtz) of 25 or more.

ber of persons screened rises until age 65 and then levels off. For advanced glaucoma, however, this ratio continues to rise rather steeply after age 65 (fig. 4). Early glaucoma and "borderline" intraocular tension were found only slightly more frequently in the older age categories, and the percentage drops after age 65. On the other hand, relatively more "borderline" and early cases than advanced were found in the 35 to 44 year age group. Among the persons with glaucoma who were 55 or over, a larger number were classified as advanced than as early or "borderline," and among those 65 or over, 64 percent had glaucoma in an advanced stage.

Since the program was specifically designed for persons 35 and over, no data are available to show the possible results of screening persons under 35. Within age groups, statistical tests show no significant difference by race or sex.

Fundus Examination

By careful fundus examinations in the Philadelphia screening, ophthalmologists discovered one patient with initial tension readings of 15 and 17 mm. Hg who was later diagnosed as having glaucoma. All other "suspicious fundus" cases eventually diagnosed as glaucoma had initial tensions of 25 mm. Hg or more.

However, mass screening is not directed toward "low tension" glaucoma, called by some authorities pseudoglaucoma (5). There is considerable evidence that this is not primary glau-

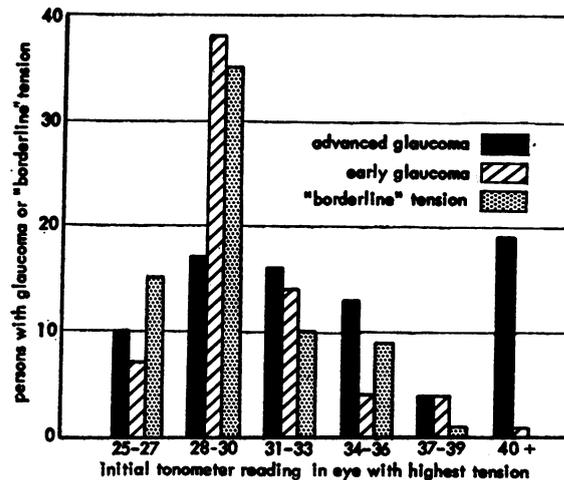


Figure 3. Number of persons with glaucoma or "borderline" intraocular tension, by initial tonometer reading (in mm. Hg Schiøtz) and by stage of glaucomatous findings.

coma at all; if and when it is, the manifestations are different. The number of cases of "low tension" glaucoma is relatively unimportant compared with chronic simple glaucoma, for which a higher than average tension is the earliest symptom (6, 7).

Nor is mass screening directed toward types of glaucoma which may be detected during acute attacks.

Readings for Right and Left Eyes

Consistently, in almost every sex and age group, the eye more frequently having the greatest tension was the left. However, distri-

Table 2. Number and percentage of screenees by age groups classified as having glaucoma or "borderline" intraocular tension

Age group	Persons screened	Persons classified as having glaucoma or "borderline" intraocular tension		Persons diagnosed as having glaucoma, by type				"Borderline" intraocular tension	
				Advanced		Early			
		Number	Percent	Number	Percent	Number	Percent	Number	Percent
All ages, 35 years and over.....	10, 000	224	2. 2	84	0. 8	69	0. 7	71	0. 7
Under 35 years.....	47	0	-----	0	-----	0	-----	0	-----
35-44 years.....	3, 006	35	1. 2	7	. 2	17	. 6	11	. 4
45-54 years.....	4, 183	90	2. 2	31	. 7	25	. 6	34	. 8
55-64 years.....	2, 389	85	3. 6	37	1. 5	24	1. 0	24	1. 0
65 years and over.....	375	14	3. 7	9	2. 4	3	. 8	2	. 5

butions of tensions for the two eyes are similar, although more left eyes have higher readings near the modal value. Whether this results from an inherent biological phenomenon or from the specific mechanics of the testing situations is not known.

As compared with criteria based on the height of intraocular tension readings, the difference between the tension readings in the two eyes proved to be of no value in case finding. (See table 3.) One glaucoma case without elevated tension on the screening test may have been suspected on the basis of a 5 mm. Hg difference between the readings for the right and left eyes. On the other hand, for more than a third (36.2 percent) of the glaucoma or "borderline" patients who had tension readings for both eyes, no difference was found. Almost two-thirds (64.3 percent) had readings within 3 mm. Hg of each other for the two eyes—a difference which some investigators have stated to be within the margin of error (3, 8). Judg-

Table 3. Number of persons examined and number and percentage classified as having glaucoma or "borderline" intraocular tension, by tonometer reading in eye with highest tension and by difference in tension between eyes

Tonometer reading (mm. Hg) in eye with highest tension	Difference in tension between eyes (mm. Hg)	Number of persons examined	Persons classified as having glaucoma or "borderline" intraocular tension	
			Number	Percent
Less than 25	All	8,567	4	0
	00-01	6,662	2	.0
	02-03	1,692	1	.1
	04-05	171	1	.6
	06+	42	0	-----
25+	All	968	217	22.4
	00-01	410	91	22.2
	02-03	305	48	15.7
	04-05	133	30	22.6
	06+	120	48	40.0
Total with known tension and classification		9,535	221	2.3
Unknown tension in one or both eyes or not classified		465	3	-----
Total		10,000	224	-----

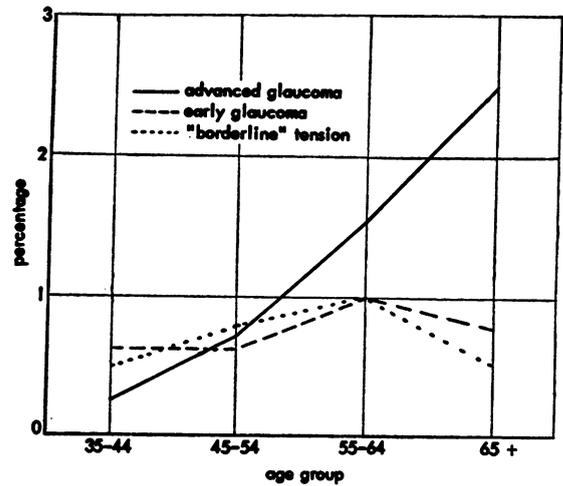


Figure 4. Percentage of persons diagnosed as having glaucoma or "borderline" intraocular tension, by age group and stage of disease.

ing from the data available, suspicion aroused by high intraocular tension may well be strengthened if there is a difference of 4 mm. Hg or more between eyes, but the latter alone cannot be considered as a case-finding device.

Discussion

How many glaucoma cases might have been found by rechecking persons whose eyes had initial tension readings of 24 mm. Hg? Retests were made on some screenees (an unknown number) who had initial tensions of 24 mm. Hg in both eyes, and two of these persons had glaucoma—advanced in one case. Undoubtedly, rechecking all eyes which had 24 mm. Hg tensions would have increased the effectiveness of the case-finding program, but at considerable cost. There were 884 persons with initial readings of 24 mm. Hg in the eye with highest tension, compared to a total of 1,056 with tensions of 25 mm. Hg or higher. Thus, lowering the screening level one point would have almost doubled the group subject to recheck, which would have been impractical for a case-finding project operating on a very limited budget.

There is a need for a specially designed project in which every one of a representative group of adults, including those with negative findings, would have repeated tonometer tests, provocative tests, visual fields charted, gonioscopic

examination, and diagnosis. For those with "borderline" tonometer readings and negative diagnoses, the tests should be repeated at intervals. Investigation is needed before we can estimate how elevated tension must be to be regarded as dangerous. Such a study would furnish a basis for estimating the number of those who might be inaccurately classified as negative in a mass screening survey. These data would enable us to compare "borderline" screening levels for sensitivity as well as specificity.

Further investigation of screening methods is fundamental to a public health approach to this problem. Although without some count of the "false negatives," we cannot accurately estimate the size and cost of the problem of undiscovered glaucoma, we know that it is large and expensive. The cost of services to the blind paid from taxes or privately donated funds has been estimated to be in excess of \$125,000,000 per year (1, 9). This sum does not include expenditures by relatives or by blind persons themselves. Nor does it include the costs of unemployment caused by blindness or any of the economic costs of partial vision.

Summary

Among 10,000 working people screened for chronic simple glaucoma by the Philadelphia Committee for the Prevention of Blindness, no differences in frequency were found by race and sex, within age groups. More cases of chronic simple glaucoma are found in the older age

groups; these cases are likely to be advanced.

The higher the intraocular tension, as indicated by a Schiøtz tonometer reading, the more specific is the indication of glaucoma, especially of advanced glaucoma. On the other hand, the "borderline" tension levels are most productive of "borderline" cases.

The need for more study, with emphasis on long-term followup of "borderline" cases, is evident from the data.

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Departmental Council Formed To Aid Secretary

To achieve maximum coordination in the administration of the Department of Health, Education, and Welfare, the Secretary has created a Departmental Council composed of top officials and heads of constituent units of the Department. Henry G. Haskell, Jr., of Wilmington, Del., has been named as secretary of the Council.